

FIGURE 1

### Patient Information

Name \_\_\_\_\_

Address \_\_\_\_\_

Home Phone \_\_\_\_\_

Work Phone \_\_\_\_\_

E-mail \_\_\_\_\_

Gender ☐ Male ☐ Female

Birth date \_\_\_\_\_ *Month* \_\_\_\_\_ *Day* \_\_\_\_\_ *Year* \_\_\_\_\_

Race/Ethnicity ☐ White/Caucasian ☐ African American ☐ Hispanic/Latino  
☐ Asian/Pacific Islander ☐ Native American ☐ Multiracial  
☐ Other

Marital Status ☐ Single ☐ Living with another ☐ Married  
☐ Separated ☐ Divorced ☐ Widowed

Education Level ☐ High school or less ☐ Vocational/technical ☐ College degree  
☐ Graduate degree ☐ Professional degree

Occupational Status ☐ Employed ☐ Student ☐ Retired  
☐ Unemployed

Insurance/Billing 1. \_\_\_\_\_ 2. \_\_\_\_\_

FIGURE 2

Patient ID: \_\_\_\_\_ Age: \_\_\_\_\_ Sex: \_\_\_\_\_ Procedure ID: \_\_\_\_\_ Date: \_\_\_\_\_

Reason for visit ☐ Routine (e.g., checkup) ☐ 1<sup>st</sup> visit to this physician, or new medical condition ☐ Follow-up for existing medical condition

Referred by ☐ Primary care physician ☐ Another specialist ☐ Self

Referring diagnosis

ICD-9 codes

2.

3.

Phenomenon category ☐ Lump/bump ☐ Discharge/leak ☐ Bleeding  
☐ Wrong direction ☐ Discoloration ☐ Intake difficulty

Other phenomenon category

*If you are experiencing a new medical problem, symptom, or condition, please fill out the following:*

Chief complaint

Symptom duration

Symptom quantity  
(disease-specific)

Symptom timing  
(disease-specific)

Symptom context

Symptom quality

Relevant past Hx

Previous consult with another physician ☐ Yes ☐ No

Received medical treatment for this condition ☐ Yes ☐ No

Previous surgery for this condition ☐ Yes ☐ No

Other

Relevant Family Hx  
(disease-specific)

*If this is a follow-up visit, please answer the following:*

Symptom evolution (per symptom) ☐ Gone away completely ☐ Improved ☐ No change  
☐ Worse

FIGURE 3

Patient ID: \_\_\_\_\_ Age: \_\_\_\_\_ Sex: \_\_\_\_\_ Procedure ID: \_\_\_\_\_ Date: \_\_\_\_\_

Are you experiencing any of the following problems?

☐ Weight loss  
☐ Weight gain

☐ Fever

☐ Fatigue

Do you have lazy eye?

☐ Yes

☐ No

Any new vision/eye problems?

☐ Yes

☐ No

If yes, please check...

☐ Blurred vision  
☐ Eye pain

☐ Double vision  
☐ Eye redness

☐ Loss of vision  
☐ Eye dryness

Are you having hearing, balance, speech, or throat problems?

☐ Yes

☐ No

If yes, please check...

☐ Trouble hearing  
☐ Loss of balance  
☐ Hoarseness

☐ Ringing in ear(s)  
☐ Ear pain  
☐ Trouble swallowing

☐ Dizziness (vertigo)  
☐ Ear discharge  
☐ Slurred speech

Have you been told you have a heart murmur?

☐ Yes

☐ No

Are you experiencing any chest pain, heart problems, limb pain, or fainting?

☐ Yes

☐ No

If yes, please check...

☐ Chest pain  
☐ Fainting

☐ Limb swelling  
☐ Limb pain on walking

☐ Fast heart beat  
☐ Irregular heart beat

Do you have asthma?

☐ Yes

☐ No

Are you having problems breathing, coughing, or coughing up anything?

☐ Yes

☐ No

If yes, please check...

☐ Trouble breathing

☐ Chronic cough

☐ Coughing blood

Are you having any stomach or digestive problems?

☐ Yes

☐ No

If yes, please check...

☐ Indigestion  
☐ Nausea  
☐ Diarrhea

☐ Heart burn  
☐ Vomiting  
☐ Constipation

☐ Abdominal pain  
☐ Regurgitation  
☐ Bloody stools

*Constitutional*

*Eye Problems*

*Ear/Nose/Throat*

*Cardiovascular*

*Respiratory*

*Gastrointestinal*

FIGURE 4

Are you having any problems urinating?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
If yes, please check...	<input type="checkbox"/> Incontinence <input type="checkbox"/> Excessive urination	<input type="checkbox"/> Pain on urination	<input type="checkbox"/> Blood in urine
Are you having any muscle or joint problems or pain anywhere?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
If yes, please check...	<input type="checkbox"/> Joint swelling <input type="checkbox"/> Joint pain <input type="checkbox"/> Joint stiffness	<input type="checkbox"/> Muscle pain <input type="checkbox"/> Muscle cramp <input type="checkbox"/> Muscle twitches	<input type="checkbox"/> Back pain <input type="checkbox"/> Neck pain <input type="checkbox"/> Loss of muscle
Are there any changes to your skin, hair, sense of feel, or sweating?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
If yes, please check...	<input type="checkbox"/> Numbness <input type="checkbox"/> Hair loss <input type="checkbox"/> Skin rash	<input type="checkbox"/> Tingling <input type="checkbox"/> Nail changes <input type="checkbox"/> Dry eyes/mouth	<input type="checkbox"/> Discoloration <input type="checkbox"/> Sweating changes
Are you having headaches/head pain, blackouts, coordination problems, or memory problems?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
If yes, please check...	<input type="checkbox"/> Headache <input type="checkbox"/> Weakness <input type="checkbox"/> Blackouts	<input type="checkbox"/> Face pain <input type="checkbox"/> Tremors <input type="checkbox"/> Trouble with memory	<input type="checkbox"/> Face numbness <input type="checkbox"/> Clumsiness <input type="checkbox"/> Trouble concentrating
Are you having any psychological issues or problems with sleep?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
If yes, please check...	<input type="checkbox"/> Hallucinations <input type="checkbox"/> Suicidal thoughts	<input type="checkbox"/> Feeling depressed <input type="checkbox"/> Inappropriate crying	<input type="checkbox"/> Trouble sleeping <input type="checkbox"/> Inappropriate laughing
Are you bleeding or have found any lumps/swelling that are new?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
	<input type="checkbox"/> Abnormal bleeding	<input type="checkbox"/> Nose bleeds	<input type="checkbox"/> Lumps or swellings
Do you have any of the other following symptoms?	<input type="checkbox"/> Excessive thirst	<input type="checkbox"/> Heat/cold intolerance	

**Genitourinary**

**Musculoskeletal**

**Skin & Breast**

**Neurologic**

**Psychiatric**

**Hematologic/  
lymphatic**

**Endocrine**

FIGURE 5

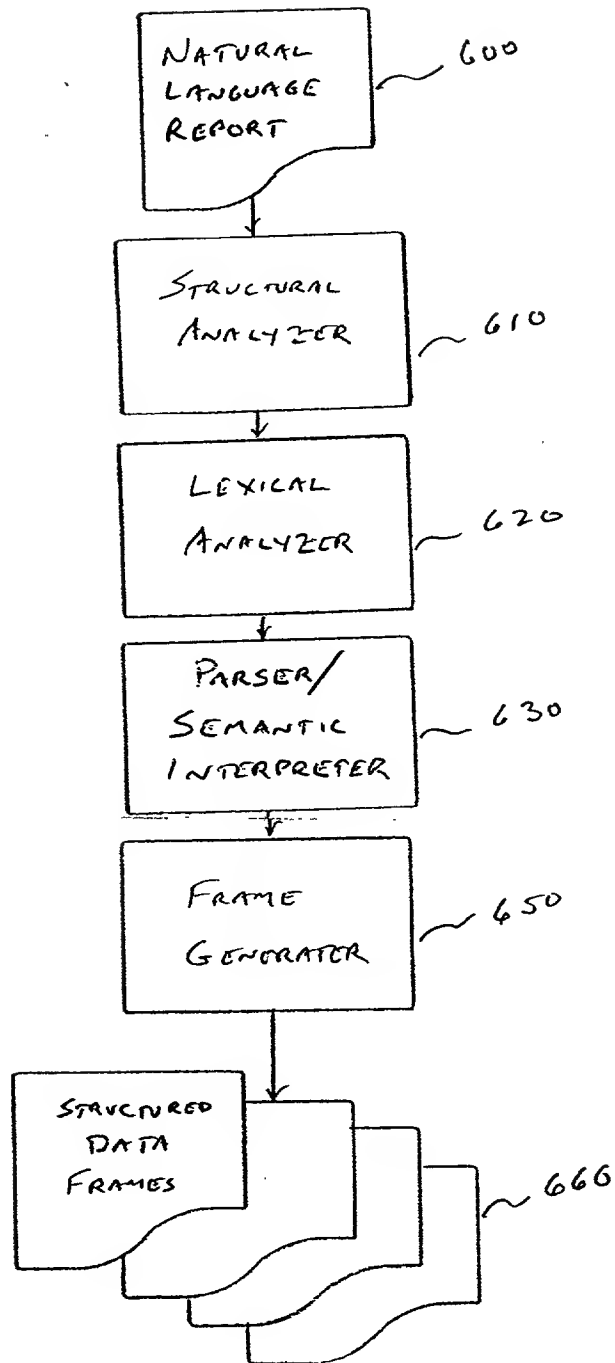
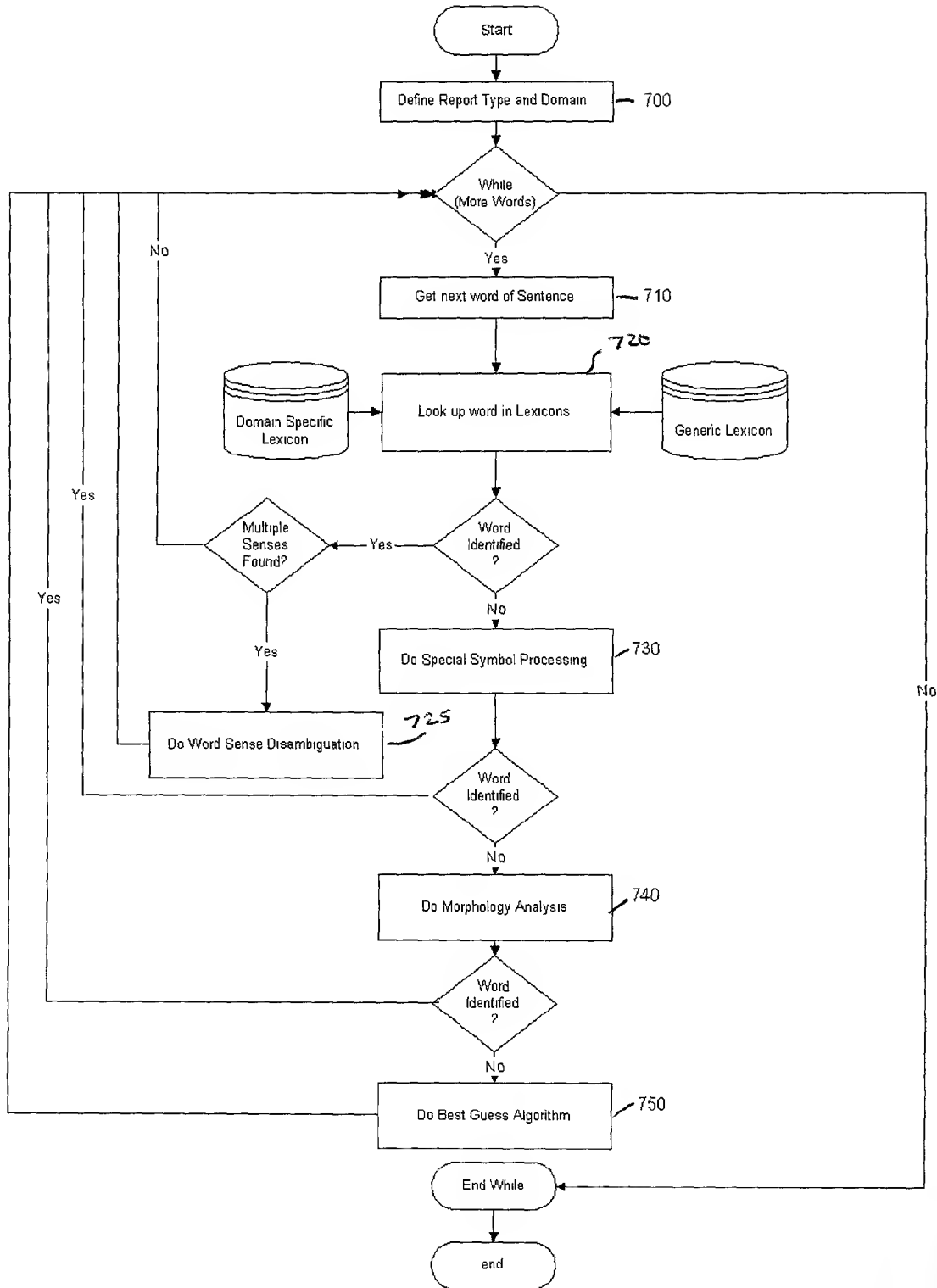


FIGURE 6

Figure 7 - Flowchart for Lexical Analyzer algorithm



**Figure 8 - Method for lexicon construction.**

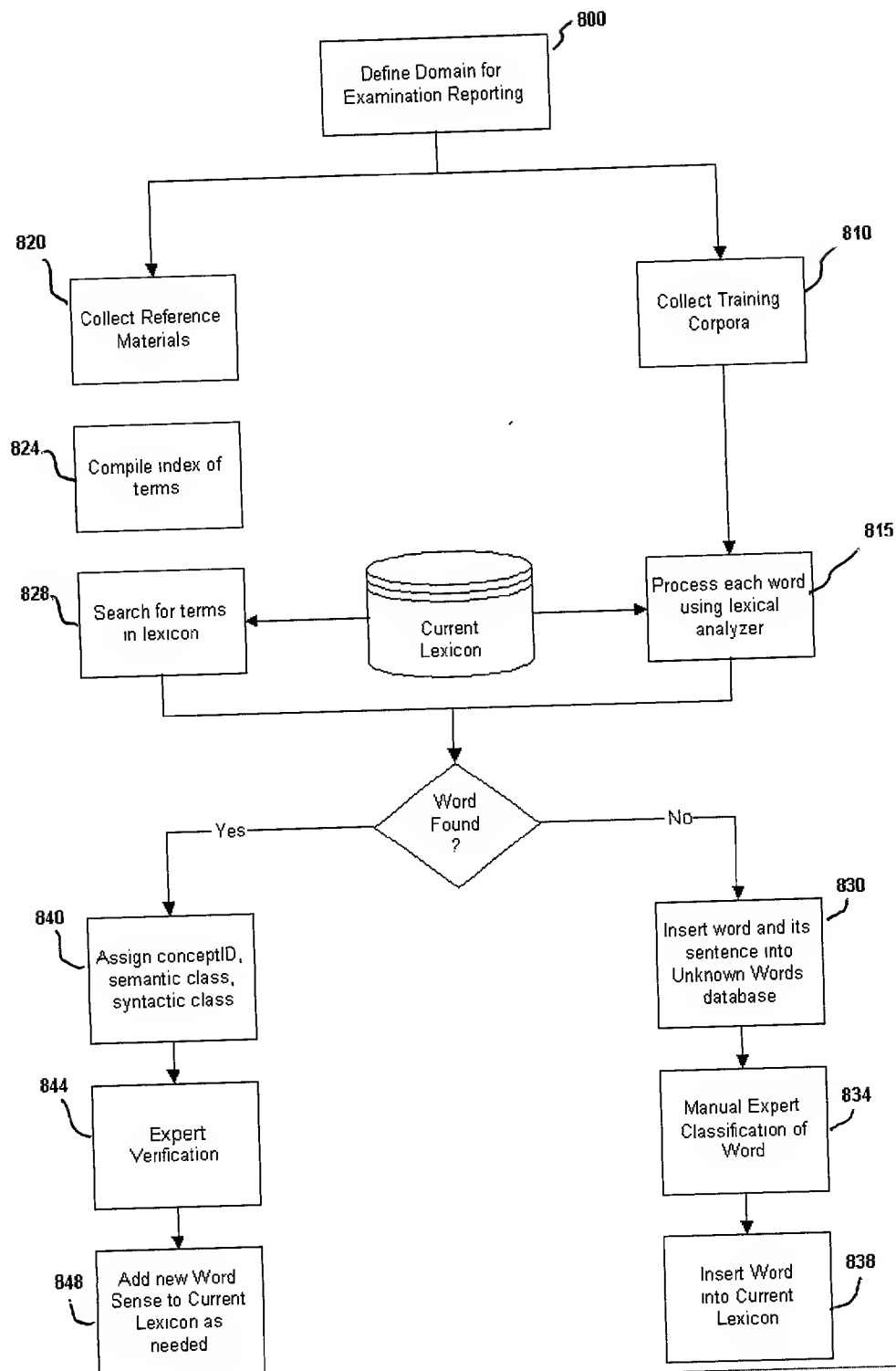




Figure 9A - Dependency diagram for sample sentence illustrating word-word linkages.

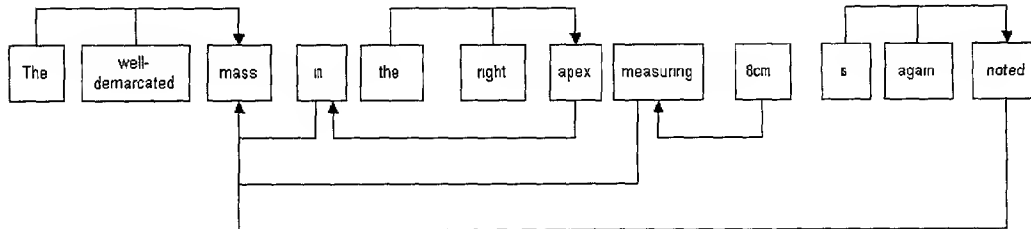


Figure 9B - Set of logical relations extracted from examples sentence in Figure 9a.

predicate	head	relation	value
hasArticle	mass	EQUALS	the
hasBorderDef	mass	EQUALS	well-demarcated
hasLocation	mass	in	apex
hasDirection	apex	EQUALS	right
hasSize	mass	measuring	8cm
hasTempMod	noted	EQUALS	again
hasAuxiliary	noted	EQUALS	is
hasExistence	mass	EQUALS	noted

Figure 10A - Input / output characteristics of logical relation classifier

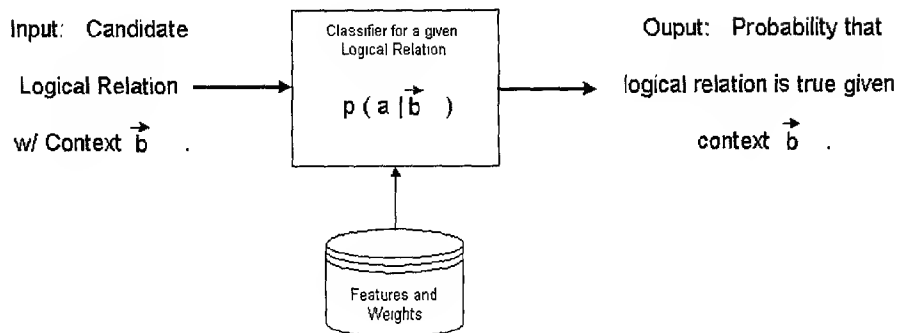


Figure 10B - Functional form of the probability distribution model.

Maximum Entropy Model used for parser / Semantic Interpreter

$$p(a|b) = \frac{1}{Z(b)} \exp \sum_{i=1}^n \lambda_i f_i(a,b)$$

$\lambda_i$  = weighting factor for feature  $i$  (Computed from training example statistics)

$Z(b)$  = normalization factor to assure that the probability is within the range 0.0 to 1.0




























Figure 10C - Definition of a binary-valued feature function to support (i) positive evidence and (ii) negative evidence

$$(i) \quad f(a,b) = \begin{cases} 1 & \text{if } (a = 1) \& b_2 = \text{true} \& b_6 = \text{true} \& b_8 = \text{false} \\ 0 & \text{otherwise} \end{cases}$$










$$(ii) \quad f(a,b) = \begin{cases} 1 & \text{if } (a = 0) \& b_2 = \text{false} \& b_7 = \text{true} \& b_8 = \text{true} \\ 0 & \text{otherwise} \end{cases}$$

Figure 11A - Solution space for the example sentence:

"The osseus and soft tissue structures of the thorax demonstrate change"

	The	osseus	and	soft tissue	structures	of	thorax	demonstrate	change
The									
osseus									
and									
soft tissue									
structures									
of									
thorax									
demonstrate									
change									

**Figure 11B** - Link probabilities of specific word-word interactions. Note that probabilities shown are for illustrative purposes only.

	The	osseus	and	soft tissue	structures	of	thorax	demonstrate	change
The				0.42	0.89		0.13		0.05
osseus			0.78		0.74				0.28
and				0.78			0.31		
soft tissue					0.91		0.42		0.31
structures									
of					0.95				
thorax						0.95			
demonstrate				0.68	0.78		0.65		
change						0.29		0.92	

**Figure 12: Dealing with Sparse Statistics.**

**Concept relaxation using type abstraction hierarchies**

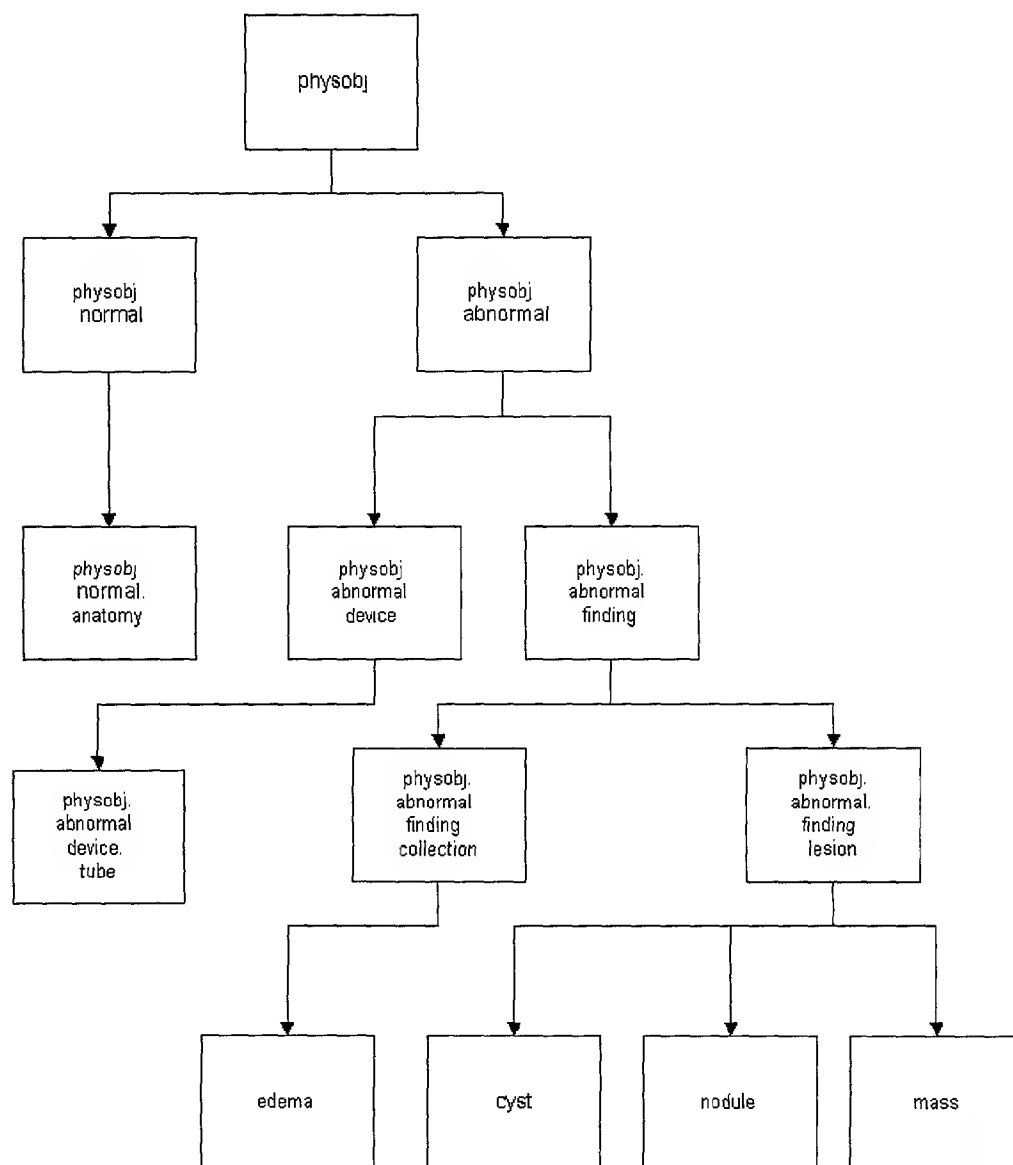
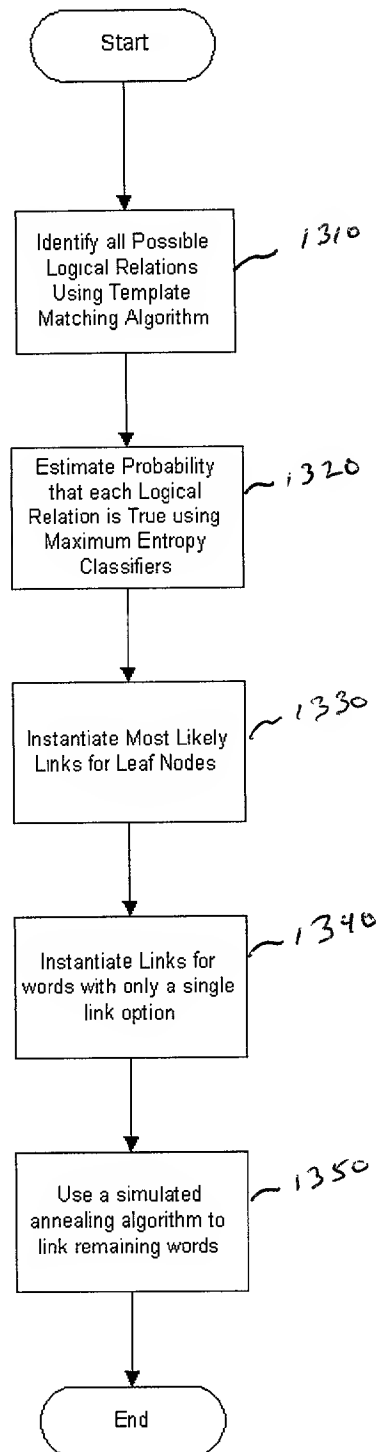


Figure 13 - Parser / Semantic Interpreter Flowchart



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Figure 15 - Output of Frame Generator for example in Figure 9a.

NLP Finding

Entity ID: 'mass'

Entity Class: FINDING Abnormal lesion

Existence

Currently

Attribute	Value
How Determined	by observation
Certainty of Existence	certain
Relevancy of Note	significant

Change (2=Currently, 1=previous exam)

Attribute	Value
Direction of Change	stable, still exists
Magnitude of Change	no change in existence

Location

Spatial Relation	Anatomy Description	Standardized Anatomy Description
'in'	right apex	apex of right upper lobe of lung

State

Current

Size

Dimension	Relation	Value	Units	Precision
Diameter	=	8	cm	approximately

external Architecture

Dimension	Relation	Value	Units	Precision
border definition	=	well demarcated	n/a	n/a